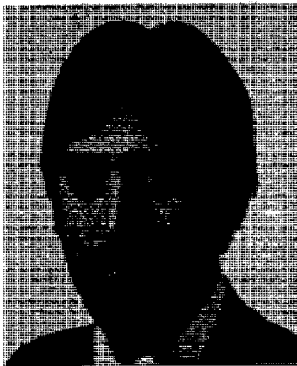# Videotex '84

THE BROADBAND SOLUTION-METROPOLITAN CATV NETWORKS

William Frezza
Program Manager
Communicom
General Instrument
USA

Current network approaches to videotex, namely the public switched telephone network and LADT, either lack the data traffic handling capacity to support a sizable videotex business or are too costly to enjoy widespread penetration in the residential market. This paper describes a broadband CATV networking approach that not only overcomes these obstacles but offers a high speed (128 kbps) capacity which will support the deployment of totally software based (downloaded) terminals.

Bill Frezza is Program Manager of the Communicom project at General Instrument. His responsibilities include development of a line of cable based videotex terminals as well as integration of the Sytek MetroNet project into the joint Cox-GI videotex program. Prior to joining General Instrument he was a systems engineer at Bell Laboratories where he co-authored Bell's Presentation Level Protocol (PLP) later to become a national videotex standard, NAPLPS.

INTRODUCTION

One of the central questions facing the videotex
industry, if in fact it is to become a significant
industry in the forseeable future, is the problem of
economically supporting communications between a large
base of residential subscribers within a metropolitan
area and the handful of major service providers serving
that area. The process of collecting, concentrating,
and switching this traffic, (a problem long ago solved
for voice telephony), has never really been accomplish-
ed for interactive data communications within a
metropolitan area. Most of the significant progress
which has been made to date has been in transporting
data across long haul networks like Telenet, which
serves a relatively dispersed subscriber base. The
local telephone exchange remains a critical bottleneck
for local distribution. Many proposed solutions to
this local distribution problem which seem attractive
at the 100 or even 1000 user level begin to exhibit
serious traffic problems at the 10,000 user level and
are totally unsupportable at the even higher
penetration levels required to make residential
videotex a commercially viable business. Other
solutions which do have the traffic carrying capacity
are inherently expensive and will likely meet with
success only in the comparatively less cost sensitive
business market. Of the available alternatives,
broadband CATV systems offer the best promise for
solving this problem. Not only are they ideally suited
for the distribution of this class of data traffic, but
they offer architectural advantages to the developers
of both videotex terminal products and videotex
services which cannot be had over narrow band networks
at any price. This paper examines a broadband approach
to the problem of choosing a "conduit" for videotex and
related services, in particular describing the MetroNet
interactive cable data network and the Communicom
videotex terminal products being developed by General
Instrument. A comparison is made to telephone and
LADT, AT&T's Local Area Data Transport system, in an
effort to bring out the strengths and weaknesses of the
various media.

THE PROBLEM

Much attention in the industry has thus far been focused on both the right service mix required to attract subscribers and the appropriate user terminal features required to support this service mix, particularly in the display area. Comparatively little attention has been paid to determining the optimum network architecture required to connect these terminals to the large host computer systems offering data services. Perhaps this is because substantial network problems are not likely to manifest themselves until after the services achieve significant penetration. Perhaps this is because the network of choice is just naturally assumed to be the ubiquitous twisted pair telephone network, or minor modifications thereof. In any case, prudent planning requires an examination of those obstacles that will have to be overcome after a successful service launch but before widespread commercial exploitation.

To date, nearly all significant videotex work has, by necessity, centered around telephone based delivery. The fundamental weakness of the existing public switched telephone network is, oddly enough, its strength. Over one hundred years has been spent fine tuning the telephone system to optimally support voice calls. These calls have very different aggregate traffic statistics than the data calls expected for videotex. Most notably, the average voice call generated in the residential environment lasts three minutes as compared to the expected fifteen to twenty minutes for videotex calls. Resources within the local telephone central office are provisioned and demand allocated based on these aggregate statistics. Clearly, this is not a problem if videotex penetration remains low. After all, households with talkative teenagers have not destroyed the technical viability of the telephone network (although the probable phasing out of flat rate local calling will forever alter the subsidies that make this phenomenon possible). If videotex penetration becomes significant, however, and some estimates run as low as 3 1/2%, this fine balance created between the supply and demand of specific switching resources in the local central office will be upset, resulting in a greatly diminished grade of

service (i.e., availability). As quoted from a former
Bell Labs engineer who was part of the original LADT
design team, "it's worse than Mother's Day" (1). It is
a very risky strategy to totally rely on a system that
strangles on its own success. Clearly, a timely
migration strategy is in order.

LADT is AT&T's suggested solution for videotex and
services like it, a response to this potential
"calamity of success". Viewed in a defensive
perspective, LADT can be seen as being as important to
protecting the existing telephone system from data as
it is to exploiting new market opportunities. But how
does LADT stack up for videotex? Its heirarchical,
packet switched architecture appears to be sufficiently
robust to carry the volume of data expected (2). It is
also very well matched to the long holding time/bursty
data traffic expected from videotex calls. But what
about the costs? An examination of the LADT tariffs
(3) filed in Florida yields an interesting insight into
the likely future of LADT. This tariff estimates a
usage charge of $14 per month for the typical
residential videotex subscriber, a pretty substantial
entry fee just to log on. This, of course, rules out
services with a utility to the end user of less than
$14 per month, even if the actual service is free.
This average figure, moreover, is based on the dial-up
version of LADT, which suffers from the same traffic
problems under concentrated loads as the existing
telephone network. It must be viewed, therefore, as an
entry strategy for LADT, which must eventually move
subscribers over to the direct connect version (data
above voice on the local loop) as penetration exceeds
3% or 4%. While there are additional benefits to the
direct connect version, such as lack of contention with
the telephone and a 4800 bps data rate vs. 1200 bps,
the tariff estimates the typical monthly bill at $40.
One has a difficult time imagining a mature residential
videotex service based on a $40 per month
communications bill.

Why, then, is AT&T agressively pursuing LADT? Inter-
estingly enough, $40 is a bargain for 4800 bps switched
service compared to existing private lines business

data tariffs, which run into the hundreds and even
thousands of dollars per month depending on the type of
line and the distance. From this, one can reasonably
expect that LADT, or something like it, will find a
happy and profitable home in the exploding business
data market. This is small comfort to the emerging
residential videotex industry, however. Hopefully,
this sobering realization will lead to the examination
of the other major conduit entering the home.

CABLE TV

As there is no monolithic "cable industry" to study,
but instead a complex conglomeration of hundreds of
operators ranging from sophisticated Fortune 500
companies to the remaining "mom and pop" operations, it
is difficult to assess cable's potential without
focussing on particular markets and systems which are
likely to be key to videotex. These, of course, are
the major urban and suburban systems generally operated
by large MSOs (Multiple System Operators) each support-
ing upwards of 50,000 subscribers. If one assumes that
videotex will be primarily a metropolitan phenomenon
driven by a handful of major service providers, then
restricting one's attention to these larger candidate
systems should not be unduly limiting. This is
especially noteworthy given the following broad
generalizations about these larger systems:

a) all of them are two-way capable, that is, sufficient
   bandwidth has been set aside (usually in the 5 MHz -
   30 MHz band) to support the future addition of
   upstream transmission,

b) many of them, especially those built in the last
   three years as well as those that will be built as a
   result of recently awarded franchises, are going
   in two-way active, with the basic cost of this
   capability already absorbed in the construction base,

c) most of these systems generally have un-utilized
   or underutilized downstream capacity, currently
   occupied by things like character generators
   carrying billboard services, and

d) almost all of the operators have some obligations
   to offer two-way interactive services as part of the
   price of obtaining the franchises.

Examining these very broad factors usually leads to
initial excitement for videotex promoters. This is
quickly followed by a growing disappointment when the
realization sets in that there is no equipment currently
available to take advantage of these opportunities on
anything but a "concept trial" basis. The fact is, most
MSOs are almost exclusively concentrating on their bread
and butter business, premium entertainment TV, and are
not predisposed to make risky investments in unproven
services. Cable equipment vendors as a group are not
technology driven, hence their entire focus has been on
meeting the immediate demands of their customers by
making more channels available to keep up with
franchising promises (witness the march from 350 MHz to
450 MHz, 500 MHz, and now 550 MHz) and on defeating
"pirates" that are sapping MSOs revenues by stealing
premium services (witness the addressability revolution).
Progress on the data communications front has been
limited, with many false starts and few successes.
Attention has also been concentrated on the business and
institutional data market, which is perceived as being
less cost sensitive, less risky, and less complicated.

So how can all of this lead to a broadband solution for
residential videotex? Two things are required. The
first is developing a system that "works" (i.e., the
traffic arithmetic adds up and the costs per subscriber
are low) and the second is convincing a skeptical
entertainment oriented customer (i.e., the MSO and his
subscribers) to buy it. General Instrument has tackled
both these problems with a data network called MetroNet
and a combined entertainment video converter and videotex
terminal, the first member of the Communicom product
line. The essential characteristics of this approach
will be described in the remainder of this paper.

METRONET

The MetroNet network is a direct offshoot of the LocalNet broadband local area network system developed by Sytek Inc., a General Instrument affiliate. (For a detailed technical description of MetroNet see reference 4.) MetroNet enhances a standard "tree and branch" cable TV system designed for the delivery of broadcast video by transforming a selected portion of the spectrum (as few as one and at most six regular TV channels) into a "global bus" switched data highway. This data highway is used to support both two-way videotex sessions between any two points on the cable and one-way "teletext" channels, which could contain the most frequently accessed frames of information as well as downloaded software. This transformation is accomplished via the installation of some relatively modest equipment in the headend and can be done, most importantly, with no topological changes in the existing cable plant. (As with any cable data system, including the two-way addressable converters currently being deployed to support multi-tiered pay TV, it requires the activation of the upstream amplifiers.)

Figure 1 shows a block diagram of the system. Up to fifty, 300 KHz wide, 128 kbps, two-way channels are created by linking a portion of the upstream bandwidth to a portion of the downstream bandwidth through a digital packet repeater in the headend. This repeater, called a DCAM (Data Channel Access Monitor) is responsible for performing noise clean up on the received packets (a simple demod-remod), checking their headers to see whether they are properly authorized to be on the system (a simple table look up), and rebroadcasting them on an associated downstream channel. Each of these fifty channels can be shared by up to 300 simultaneously active users utilizing a highly efficient channel contention scheme (CSMA/CD) which is commonly used in most local area network products. Any terminal can be directed to tune its modem to any one of these fifty data channels, thus making every host computer system on the network directly accessable.

The "teletext" transmitter in the headend creates an additional fifty 300 KHz wide, 128 kbps, one-way teletext channels which can also be received by any terminal via

FIGURE 1 : *METRONET ARCHITECTURE*

proper tuning of its modem. (This is not to be confused
with either Vertical Blanking Interval teletext or full-
field teletext which modulates data onto the video
carrier.) The teletext transmitters can be uploaded at
various times during the day over the two-way channels
from any authorized service provider's host computer on
the network. This gives the service provider the capa-
bility to offload the most frequently accessed frames
onto the teletext system, which is inherently load
independent. An application running in each terminal
will decide whether a requested frame is available via a
teletext channel or can only be obtained via a two-way
videotex session, blending the information received from
these two sources in a manner that is transparent to the
user. This will not only reduce the total traffic load
on the system but will have significant ramifications on
the economics of service providers, who clearly need a
way to dramatically reduce their capital investment in
large host computer systems. The teletext transmitters
also have the important job of distributing the basic
terminal operating software, which is downloaded into
each videotex terminal whenever power is applied (more on
this later).

The DCAM and the teletext transmitter take care of the
fundamental data distribution chores of the network. It
is important to note that these are not packet switches
and, hence, require no sophisticated protocol
intelligence nor expensive processing power, as do the
switching nodes in LADT. They can also be deployed
modularly on a per channel basis, reducing the initial
capital costs required to get a system started with
relatively few subscribers.

Managing these data channels, establishing sessions
between users and service providers, and collecting
transport billing statistics is the job of the Network
Control Center. This can be attached anywhere on the
network and does not need to be co-located with the
headend. The network control center is also not involved
in ongoing packet switching, and therefore can be
implemented on a relatively inexpensive mini or even
microcomputer hardware base.

Service providers' host computers, both large and small,
can attach to the network at any point on the system,
again with no requirement to be co-located or trunked
into the headend. They do this through an X.25 interface
called an XGATE, which supports a standard X.25 protocol
at speeds up to 56 kbps. Translation into the internal
MetroNet protocols is accomplished within the XGATE and
is transparent to the service provider. Public data
networks such as Telenet and Tymenet can attach to
MetroNet via these XGATEs as well, providing access to
remote services such as The Source and Compuserve.

Multiple cable hubs and even multiple adjacent cable
systems under common administrative control (for data)
can be interconnected via inter-hub links. These can not
only be used to increase the capacity of a single cable
system by dividing it down into multiple sub-networks but
can extend the geographic coverage of a MetroNet beyond
the bounds of a single cable franchise.

With the configuration described above, utilizing the
same traffic model as that used in the LADT tariff, a
single MetroNet hub can be shown to support upwards of
100,000 videotex subscribers, with multiple hubs
supporting even more. Since most cable hubs usually serve
no more than 50,000 total subscribers, enough headroom
remains in the traffic model for the services to be
tremendously successful without choking on the resulting
traffic. This can be done, moreover, at an estimated
cost of less than one tenth of the capital installed cost
per subscriber as LADT.

Remaining to be described are the most common elements on
the network, namely the subscriber terminals. As will be
seen in the next section, these terminals can draw on the
unique architectural strengths of MetroNet, as well as
the availability of entertainment video, to create an
integrated system of unparalleled performance and
flexibility.

COMMUNICOM

The planned Communicom terminal family, all based on a
common architecture and implementation, has three
members. These are:

SAU - Subscriber Access Unit. The SAU is an
intelligent, frequency agile, 128 kbps
modem. It allows the connection of a
customer owned terminal or PC to MetroNet
via a standard RS-232 or backplane
connection, depending on the configuration.

VOT - Videotex Only Terminal. The VOT is an
intelligent, interactive graphics terminal
containing an integral SAU which supports
NAPLPS (5) videotex services, single and
multi-user animated video games, and down-
loaded software. It can be used in
conjunction with any standard CATV
converter or used alone. In either case
the home TV, as usual, is used as the
display device.

VVT - Video Videotex Terminal. The VVT integrates
a VOT with an addressable CATV converter.
This will support not only videotex services
and standard video entertainment services
(e.g., HBO) but novel combinations of video
and videotex such as video home shopping.

The members of this terminal family share a unique
architectural characteristic in that the entire terminal
operating system, communication software package, display
protocol package (NAPLPS or any other display standard),
and user interface software are all downloaded over the
cable into RAM each time the terminal is turned on. One
or more of the fifty MetroNet teletext channels are
dedicated to distributing this software, which allows the
download to be accomplished in a load independent manner
(i.e., no incremental network traffic is generated even
if 20,000 subscribers turn on their terminals
simultaneously). The speed of these channels (128 kbps)
also means that the user will only have to wait a matter
of seconds for the download to complete.

This totally software based architecture is critical for
two reasons. The first is that it allows the terminal
software to be improved and corrected even <u>after</u> the
product is delivered and in use. With MetroNet, the
system operator can update the software in hundreds of
thousands of terminals merely by uploading a new version
into the teletext headend. The second key ability is
that individual software modules can be paged off of the
teletext channels on demand, supporting a wide variety
of terminal software configurations tailored to each
application. In a sense, the teletext channels are being
used as free read only disks. This will allow, for
example, the bulky NAPLPS software package to be replaced
with a streamlined animation driver when the user
switches from frame retrieval videotex to action video
games, or the overlay of a BASIC interpreter if the user
wishes to do home computing.

The remaining characteristics of these terminal products
fall well within the mainstream of the videotex terminal
and low cost home computer industries, which are quickly
becoming commodity businesses. The strengh and
uniqueness of the products are clearly drawn from
MetroNet.

CONCLUSION

Hopefully, this brief description of MetroNet and
Communicom has shown that an extremely powerful and
economical system solution of the metropolitan
distribution problem can be achieved. With a broadband
approach such as this, the traffic arithmetic adds up*
and the major component of the overall cost per

---

* Details are left as an exercise to the reader. Assume
  50 two-way channels at 128 kbps with a CSMA/CD protocol
  that permits 70% channel utilization. Allow 15% for
  protocol overhead and use your own numbers for
  average throughput per terminal and peak port
  occupany. Don't forget the effect of the offloading
  onto the teletext channels.

subscriber is placed in the home terminal, where it belongs, and not in the network, which after all is nothing but a "conduit" as far as the subscriber is concerned. Manufacturing this terminal at a price low enough to achieve widespread penetration remains a challenge that depends primarily on the volumes achieved as well as the manufacturers' experience in cost reduced off-shore manufacturing. Time is on our side on this one, if the key pioneer service providers can hold out, as the ongoing decline in the cost of the critical electronic components shows no sign of letting up. Low cost manufacture has also been a major driving force in the cable industry for some time now (there is no need to get used to competition as if it were a new phenomenon) so prospects look good for a cable approach to videotex if the product can be sold to an entertainment oriented cable MSO. This is where the combined video videotex terminal comes in, which allows videotex to be marketed to individual subscribers as just another premium tier of cable services. This avoids forcing an all or nothing purchase decision on an uneducated consumer for an unproven medium in the face of direct competition from heavily promoted home computers. The enhanced animation and video game capability of Communicom, especially the ability to play multi-user interactive games with other subscribers on the network, should also appeal to an entertainment oriented market. (Even videotex purists have to admit that games are the most popular service on any system, even when the games are awful as they almost universally are on frame retrieval videotex systems.)

Time, arithmetic, and economics will solve the dilemma of delivery. The one thing that is safe to predict is that sooner or later videotex is going to happen. When it does, the choice of conduit will be limited, as only cable operators and the local telcos have the historical and political prerogative of wiring up homes. Each has their own entrenched turf to exploit (video distribution and local telephony) and each is eyeing the remaining open field (data). Because they both have an enormous investment in existing plant, the battle will by necessity be between a switched, twisted pair approach and a multiple access, coaxial cable approach. (Fiber optics, attractive as it is for high density trunking, is still a long way off as an economically viable medium for local distribution.)

Architecturally, cable has the edge for carrying the class of data traffic likely to be produced by videotex users. Its biggest drawback is its geographic distribution. Even in the big metropolitan areas, cable isn't everywhere. The fringe neighborhoods and rural communities will have to be left to the local telephone company, who are the only ones in a position to offer universal service. This will leave videotex service providers in the interesting position of having to play a straddle between cable and telephone in order to optimally cover a region. This should make for some fascinating business dynamics.

REFERENCES

1. "Firm plans to link videotex service to cable TV lines", interview with R. McNamara, Infoworld, Volume 5 #28, July 1983, P. 17

2. David B Loring, "Videotex Highways: The Telephone Approach", Proceedings of Videotex 83, Online Inc.

3. Local Area Data Transport (LADT) Service, General Subscriber Service Tariff, Southern Bell Telephone Company, April 15, 1983

4. Mete M. Gur, "An Analysis of the Networking Requirements for a Residential Two-Way CATV System: MetroNet", Sytek Inc., IEEE-Globecom - 83, November 28, 1983

5. "North American Videotex/Teletext Presentation Level Protocol Syntax (NAPLPS)", ANSI X 3.110/CSA T5000-1983.